EAFFRO OCCASIONAL PAPER 3

EAST AFRICAN INLAND FISHERIES RESEARCH ORGANIZATION, JINJA, UGANDA

ANNUAL REPORT FOR YEAR 1948

A. Introduction

The laboratory at Jinja is being developed as a centre for hydro-biological research in East Africa. It has been built and is at present wholly financed from a grant from the Central Research Allocation of the Colonial Development Fund. The building contains six laboratories in addition to a library, common room and general office. A maximum number of ten research workers could be given laboratory accommodation. However, shortage of living accommodation will limit the numbers who can work here for the next year or two. At present there are houses for four European staff. Additional quarters will, it is hoped, be built at the rate of at least one house annually.

The permanent European staff will number six, and it is hoped that we shall always have working in the laboratory two or more visiting scientists. A fund exists to meet some of their expenses.

The laboratory is equipped with all essential apparatus for biological and hydrological research, and possesses two motor launches as well as dinghies. The larger launch is suitable for long trips on the lake, when it is necessary to be away for several days at a time.

A preliminary survey in the vicinity of Jinja over an area of ninety square miles has been undertaken in order to discover the general distribution of the various species of fish and relate their occurrence to depth of water and the nature of the lake bottom, etc. Work has been started on the habits and life histories of the more important fish. As the permanent staff is increased, work on the plants, algae, plankton and aquatic insects will be undertaken, and also on the principal chemical and hydrological features of the lake.

Data have also been collected from some of the smaller lakes in the neighbourhood, in an attempt to elucidate some of the factors which determine the density of Tilapia populations; and also to discover what factors, both environmental and hereditary, cause these fish to become mature at different sizes in different bodies of water. This latter point is of considerable economic importance when considering which species of Tilapia should be introduced into lakes or dams, or when considering which species may be most suitable for rearing in fish farms.

The intention is that this organization will expand its work to other lakes and inland waters, and that it will establish substations as necessary. In particular it is hoped to build a substation on Lake Tanganyika in the near future. Apart from the economic importance and special scientific interest of Lake Tanganyika, the need for this substation has been emphasized by the inability to reach conclusive results concerning the growth rate of fish in Lake Victoria. The difficulty in determining the age of fish from Lake Victoria is due to the absence of any marked seasonal variations in the condition of the lake. Lake Tanganyika shows marked seasonal variations so that data collected from are likely to provide valuable "yard sticks" for comparative studies in other tropical lakes.

B. Fishing Experiments (Officer specially concerned - Mr. S.H. Deathe)

(a) Gill netting. The preliminary netting experiments started in 1947 from Kisumu and later in that year from Jinja, showed that gill nets fished on the bottom gave better catches than nets fished at the surface.

The survey of species and quantities of fish occurring in Lake Victoria, initiated by those experiments, was continued in 1948 by fishing two comparable fleets of gill nets of 5, 4, 3 and 2 inch mesh, one fleet on the bottom and one at the surface. These fleets were used to discover the nature and extent of the fishing grounds within reach of Jinja. The numbers of fish caught are not indicative of potential commercial catches, as these nets were often set in places where negative catches might be expected, whereas in a commercial fishery nets would continue to be set only in those areas where good catches were expected.

The average catch of each species caught in the nets was higher in the bottom than in the surface nets except for Alestes and Labeo and small Tilapia. Forty times as many small Tilapia, all immature fish, were caught in the two inch mesh surface nets, and three times as many in the three inch mesh surface nets, as in the corresponding bottom nets. On the other hand for adult Tilapia the bottom nets were the more effective, five times as many being taken in the four inch mesh bottom net and nearly twenty times as many in the five inch mesh bottom net, as in the corresponding surface nets. Mormyrus were only caught in nets set on the bottom. Alestes and Labeo were only caught in nets set at the surface.

To test the effect of the colour of the net on the catches another fleet of nets of the same meshes, dyed black, was added to the bottom fleet in October 1948. Dyed nets of heavier twine, 3 ply and 4 ply, were also added to the bottom fleet in an attempt to find a net which would catch Mormyrus and numerous smalll species of Haplochromis, etc., without destroying young Tilapia. In these experiments undyed nets fished slightly better than those which had been dyed and further work on this is necessary as tar was used for the dying and traces of oil and smell were for a long time noticeable on the dyed nets.

The following kinds of fish were caught:-

Mormyrus. These were only caught on the bottom and were taken in all kinds of nets used. The three inch mesh gill nets and trammel took the highest number, averaging 16 and 9 Mormyrus per net respectively. Mormyrus when salted and smoked makes a good kipper, But for successful kippering the Mormyrus must be fresh. As they are generally caught a considerable distance from the mainland fast transport would be necessary to land the catch in fresh condition at smoke houses.

Tilapia. As already mentioned, results show that mature Tilapia are caught more frequently near the bottom and that small immature Tilapia are caught mainly near the surface. These facts, if confirmed, raise the question whether small mesh nets should be allowed to catch Mormyrus and Haplochromis provided they are fished on the bottom.

Haplochromis. Species of Haplochromis were found in all situations in deep and shallow water, at the surface and on the bottom. They were caught mainly in the small meshed nets, the bottom nets catching more than the surface nets.

Other Fish. Fair numbers of Bagrus were taken in all the bottom nets in both deep and shallow water. Clarias, Schilbe, and Barbus species were taken in both bottom and surface nets. Alestes and Labeo were caught in the surface nets, mainly of two inch mesh, and a few Synodontis and Gnathonemus were caught in bottom nets.

These netting trials have confimred the earlier findings that fishing on the bottom is more effective than fishing at the surface. It is very desirable that these experiments should be repeated as soon as possible in other areas of the lake, and particularly in areas where intensive commercial fishing is carried out. The methods of setting nets on the bottom have been demonstrated to some senior fishermen from the Sese Islands. It remains to be seen whether these methods will be adopted.

(b) Trawling and other fishing methods. A certain amount of trapping, long-lining, seining and trawling with both an otter and a beam trawl was carried out. Only in the case of the otter trawl have sufficient trials been made to draw any conclusions. This trawl showed great possiblities; in one 30 minute haul on a muddy bottom 100 lbs of fish was caught, made up of:-

971 Haplochromis, 9 Tilapia (only one of which was immature), 4 Bagrus, 5 Mormyrus, and 6 Clarias.

It is possible that trawling for Haplochromis could be developed into a successful subsidiary industry on Lake Victoria).

C. Fish Research (Officer specially concerned - Miss R.H. Lowe)

Since arriving in Uganda in November, 1948, a collection of the main species of fish occurring in Lake Victoria near Jinja has been made. The fish have been identified where possible and data collected on their food and breeding condition. Special attention has been paid to the following:-

(1) The ecology of the two species of Tilapia, and particularly to possible ways of determining the ages and growth rates of these fish since such knowledge is essential for the calculation of mortality rates.

(2) The ecology of the Mormyrus which have been so abundant in the experimental catches.

(3) The differentiation of the various species of Haplochromis.

A start has also been made in comparing the ecology of the different species of Tilapia in different waters, and of the same species in different lakes. In this connection a visit was paid to the Koki Lakes in Uganda, Kijanebalola, Chanagwora, and Kachira, and to Lake Nabugabo, to collect data on growth and breeding size of the Tilapia in relation to the type of water. Results of such studies should yield knowledge regarding the best species of Tilapia for stocking and for use on fish farms. The size at which Tilapia mature is of considerable importance as the growth rate decreases very much after they become mature. Also the variations of one species under different conditions should give information regarding the value of the characters on which specific distinctions are at present based.

(1) Lake Victoria Tilapia

Tilapia from Lake Victoria have been examined in detail. The criteria used by Graham (1928) to separate the two species T. esculenta and T. variabilis have been examined and found valid for Tilapia of more than about 12 cm. long, but not for smaller fish. This means that it is impossible to be certain of the species of young Tilapia and even of adults if they are breeding at a small size, e.g. in dams.

The gill nets were found to be highly selective of the length and to a certain degree of the 'condition' (i.e., Weight for length) of the Tilapia.

The sizes and weights of Tilapia caught by the different nets were:-

Table I

Mesh of net	Length Range cm	Modal Length cm	Modal weight gm	Average number caught per net		Average weight caught per net	
				surface	bottom	surface	bottom
2"	13 - 16	14	44	3.0	0.07	132.0gms (0.29 lb)	3.1 gms (0.007 lb)
3"	18 - 23	20	150	1.90	0.65	285.0gms (0.63 lb)	97.5gms (0.21 lb)
4"	24- 28	26	360	0.18	1.0	58.8 gms (0.13 lb)	360.0gms (0.79 lb)
5"	29 - 32	30	580	0.11	2.0	62.6gms (0.14 lb)	1160.0gms (2.56 lb)

The relationship between weight and length suggests that in T. esculenta the growth pattern and minimum breeding size is the same in male and female fish. In some other species of Tilapia (e.g. T. shirana from Lake Nyasa) the breeding males are larger than the females, and it has been suggested that this character is important in showing to which group of Tilapia the various species belong.

Tilapia stomachs were examined in order to determine:-

(a) whether Tilapia feed on bottom algae and so are restricted to certain areas, and

(b) whether the food eaten varies with the season or sexual state of the fish. It was found that the amount of food varies greatly with the condition of the gonads, nearly all the ripe males examined had empty stomachs and intestines, and ripe and spent females generally contained only traces of food. This fast of the male associated with spawning may explain why the male of this species does not achieve a greater size than the female who fasts when brooding the young in her mouth.

The appearance of the ovaries shows that (unlike the Lake Nyasa Tilapia) the females probably have several batches of young in rapid succession. Ovaries have been preserved for more thorough examination.

Some completely ripe and 'running' T. esculenta were taken in Macdonald Bay in January and also in Thruston Bay and in Pilkington Bay in February; these fish were in a condition to suggest they were on or near spawning grounds.

The smallest ripe male and female T. esculenta seen in this area of Lake Victoria were 28 cm. and 26 cm. respectively. T. esculenta in Lake Nabugabo were found to to be ripe at 22 cm. (female) and 23 cm. (male). T. esculenta which have been living for generations in a dam were ripe at 15 cm; the stomachs of these fish contained inorganic mud (and in one case small frogs) suggesting that their normal food must be very scarce in this dam.

Age and Growth of Tilapia

It is essential for sound fishery policy to be able to determine the age of fish. This is necessary to find out how fast the fish grow and how long they take to reach maturity, and also to determine mortality rates and estimate populations. In temperate regions where there are well marked seasons and where the fish generally have definite breeding seasons, the age of fish can generally be determined byrings on the bones or scales. In tropical waters, where there are no well marked seasons, and where the fish often breed several times a year and at all times of the year, the problem presents peculiar difficulties.

On Lake Nyasa it was found that zones on the opercular bones could be used as a guide to the age of Tilapia, and an attempt is now being made to see whether these bones could be used for the purpose in Lake Victoria fish. In addition scales and in some cases vertebrae, otoliths, fin rays have also been collected together with the relevant data regarding weight, length, etc.

The opercular bones of Lake Victoria Tilapia were found to have definite zones, though for only about 10% of the fish examined could definite counts of the number of zones be made. Thise counts suggested the same pattern of growth as in the Lake Nyasa Tilapia. If the zones are annual it would seem that the Tilapia mature in about four years, whereas Graham (1928) concluded, "... it appears unlikely that the ngege will take much longer than one year to reach sexual maturity." Measurements of the positions of the zones on the bones suggest they are put on at fairly regular intervals. Examination showed that new zones are started independently of the time of year, and the sex and gonad condition of the fish. The zones are therefore not simple feeding or spawning marks, and contrary to the results obtained from Lake Nyasa Tilapia, the assumption of new zones could not be related to the "condition" of the fish.

These results, although not yet conclusive, point to the need for examining bones from fish of known age (e.g., from dams), and from natural waters, such as Lake Tanganyika, where seasonal variations in the environment are likely to cause variations in the growth rate and corresponding markings on the bones.

(2) Mormyrus kannume

The sizes and weights of Mormyrus caught in the different nets were:-

Table II

Mesh of Net	Length range cm	Modal length cm	Modal length cm	Average number caught per net	Average total weight caught per net	
					gms	lbs
2"	16 - 21	18	60	4	240	0.5
3"	24 - 36	28	224	16	3584	7.9
4"	31 - 43	37	510	7.8	3978	8.8
5"	40 - 53	43	800	0.9	720	1.6

The number and weight of fish caught are not indicative of potential commercial catches, as explained above.

Except in very deep water (100 feet or more) the three inch mesh yielded the highest number of Mormyrus, but the weight of individual fish caught in the 4 inch net was rather more than twice that of fish caught in the 3 inch net.

Possible commercial catches are indicated by the average catch of Momryrus from six hauls in a good Mormyrus area given in the following tables:-

Table III

Mesh	Average catch per set of net	
	Number of fish	Weight in lbs
2"	13.0	1.7
3"	81.7	40.3
4"	39.2	44.0
5"	5.8	10.0

The capture of numerous small Mormyrus between Dagusi Island and the mainland, where there is a strong current, is interesting and suggests a movement of these fish, as this was not an area where one would expect many.

Nothing is yet known of the breeding habits of Mormyrus. The only "ripe" and "spent" Mormyrus seen came from inshore rather than deep water. No "running" males have yet been seen.

Females of 18 cm upwards were found to be "ripening" but the smallest male in which the gonads were developing was 26 cm. Females up to 47 cm were seen, and males to 58 cm., (4½ lbs.). About 20% of the females, and considerably more of the males, in the 3 inch nets were immature fish.

From the appearance of the ovaries it seems that the Mormyrus female must spawn several, perhaps three, times in rapid succession and then have a resting period before the next spawning phase. There is much variation in the size of the ovary even when the size of the ripening ova is the same. Mormyrus from 45 feet of water in the Napoleon Gulf in November had particularly large ovaries, well over 10% of the body weight.

Plotting weight against length has shown that the growth pattern is the same in males and females, immature and mature Mormyrus, Unlike the Tilapia, mature Mormyrus continue to grow, probably at nearly the same rate as the immature fish.

The opercular bones of Mormyrus have a central "core" then well marked zones at very regular intervals, more regular than in Tilapia. A detailed examination of the bones from 36 Mormyrus showed these zones to be unrelated either to the sex or gonad state of the fish, or to the time or place of capture. No relationship could be found between the start of a new zone on the ed of a bone and the "condition" of the fish. It seems likely that these zones must reflect some internal "growth rhythm" as they occur at such regular intervals.

All the Mormyrus stomachs examined contained the larvae of "lake flies", Chaoborid or Chironomid larvae, together with algae and mud from the lake bottom.

(3) Haplochromis Species

More than 50 different species of Haplochromis are recorded from Lake Victoria. Many of them are present in enormous numbers and they are important to the fisheries as many of them prey on young fish, including Tilapia, and others may compete with the Tilapia for food. The present key for the identification of Haplochromis species is of very limited use, and a reference collection of the different kinds is being made with the long-term aim of trying to produce more satisfactory key to the different species. The larger kinds of Haplochromis, which grow to about 24 cm. and $\frac{1}{2}$ lb. weight, and which are likely to be the more important economically, are being studied first.

It is thought that more than twenty "species" of Haplochromis were represented in the catches made near Jinja and Dagus Island. Haplochromis of different "species" were found to be breeding at the same time and in the same areas. It would be interesting to know how the many morphologically similar "species" manage to keep separate, if indeed they really do keep separate.

Representatives of another genus, Astatoreochromis alluaudi, closely related to Haplochromis, are common in this area. These fish grow to about twenty centimetres in length and feed on molluscs, so this species may prove of value for stocking dams where there is danger of Bilharzia.

D. Fish Blood (Officer specially concerned - Mr. C.C. Cridland).

Work on the histology of fish bloods has been started. This study may help to elucidate some of the problems concerned with the differentiation of closely related species of fish, and also provide information concerning the normal fluctuations in "condition" and certain pathological states. Further the development of the necessary microscopical techniques will prepare the ground for other cytological investigations, such as chromosome counts.

E. Administrative Matters

The building of the laboratory and ancillary buildings was completed and equipment was installed towards the end of 1948. A fourth European staff house and some African quarters were built during the year.

The European staff consists of:-

Mr. R.S.A. Beauchamp, Director

Miss R.H. Lowe, M.Sc., Fishery Research Officer
(arrived 11th November, 1948)

Mr. S.H. Deathe, Assistant Fishery Research Officer
(proceeding on leave to U.K. 31st March, 1949)

Mr. C.C. Cridland, Laboratory Superintendent.

It is understood that two additional research officers have been appointed by the Secretary of State and are now undergoing training in Britain with a veiw to taking up appointments at Jinja at the beginning of 1950.

April, 1949.